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TURN CYCLE TIME PREDICTION FOR RUBBER TIRED SKIDDERS IN THE NORTHERN ROCKIES

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ABSTRACT

A study of rubber tired skidders shows cycle turn times are best predicted by categorizing the skidders as small or large and basing the classification on weight and horsepower. Regression equations show that turn times for heavier skidders can be predicted with better accuracy than can turn times for the light weight skidders.

KEYWORDS: rubber tired skidders, cycle turn time

In the past decade articulated rubber tired skidders have largely replaced tracked vehicles for ground skidding, especially for less than 35 percent slopes. The skidders have two principal advantages over tracked vehicles--speed and maneuverability. For most tracked vehicle/skidder models of comparable size, skidders are usually less expensive because of the lower cost of the undercarriage.

Over two logging seasons 10 different skidder models of seven different manufacturers were studied. The studies included a total of 579 skidding turns.

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EQUIPMENT AND CLASSIFICATION

All of the skidders studied were articulated with an integral arch and chokers. A summary of the skidders by size class and other characteristics is given in table 1. For analysis three classifications were assumed, small, large, and all skidders. The smaller skidders generally weighed from 10,000 to 12,000 pounds (4,536 to 5,443 kg), and had about 75 horsepower and a synchromesh transmission. The larger machines had powershift tranmissions, weighed from 15,000 to 18,500 pounds (6,804 to 8,392 kg), and averaged about 130 horsepower. The large skidders were capable of the greatest speed.

Table 1.--*Equipment classification and characteristics*

	Characteristics							
Classification	Make (model)	Transmission	Horsepower	Weight pounds (kilogram)	Wheelbase feet (meters)	Tire width inches (meters)	Maximum travel speed miles per hour (kilometers)	Clearance feet (meters)
Small	John Deere (440 A)	synchro	70	11,920 (5,192)	7.4 (2.3)	14.9 (.38)	16.0 (25.7)	1.5 (.46)
	John Deere (440 B)	synchro	70	12,250 (5,336)	7.4 (2.3)	16.9 (.43)	17.5 (28.2)	1.5 (.46)
	Pettibone (Master 8)	synchro (standard)	79	11,150 (4,857)	7.5 (2.3)	12.0 (.30)	15.5 (24.9)	1.5 (.46)
	International (S-7 B)	synchro	85	10,500 (4,574)	7.7 (2.3)	16.9 (.43)	16.0 (25.7)	2.0 (.61)
Large	Clark (667)	powershift	109	18,520 (8,067)	9.1 (2.8)	18.4 (.47)	18.0 (29.0)	1.7 (.52)
	Caterpillar (518)	powershift	120	17,300 (7,536)	9.4 (2.9)	18.4 (.47)	17.0 (27.4)	1.4 (.43)
	Clark (666)	powershift	128	14,900 (6,490)	8.7 (2.6)	18.4 (.47)	28.4 (45.7)	1.7 (.52)
	Timberjack (404)	powershift	130	16,000 (6,970)	9.6 (2.9)	18.4 (.47)	18.0 (29.0)	1.9 (.58)
	Garrett (22)	powershift	135	15,400 (6,708)	9.0 (2.7)	18.4 (.47)	19.4 (31.2)	1.9 (.58)
	International (S-11)	powershift	150	18,500 (8,059)	9.6 (2.9)	18.4 (.47)	23.3 (37.5)	2.1 (.64)

ANALYSIS AND PREDICTION EQUATIONS

A stepwise regression analysis was performed on the data. The variables of distance, volume, number of logs, weight, slope and various transformations totaling 44 variables were used. The transformations did not appreciably improve the correlation coefficients so the final equations contain some combination of the following principal variables:

NL = Number of logs

VOL = Volume in board feet (m^3)

WT = Weight of turn in pounds (kg)

DITOT = Total skidding distance in feet (m)

TT = Turn time in minutes

Equations for Turn Time

Large tractors:

$$TT = -0.1971 + 1.1287\ NL + 0.0045\ VOL + 0.0063\ DITOT \qquad (1)$$
$$R^2 = 0.8421$$

Small tractors:

$$TT = 6.58 - 0.368\ NL + 0.00065\ WT + 0.0168\ DITOT \qquad (2)$$
$$R^2 = 0.5483$$

All tractors:

$$TT = 2.57 + 0.8228\ NL + 0.0054\ VOL + 0.0078\ DITOT \qquad (3)$$
$$R^2 = 0.7550$$

Data on the variables are summarized in table 2.

Table 2.--*Summary of all data*

	Maximum	Minimum	Mean
Board ft per hour	12,000	45	2,274
(m^3)	(54)	(0.20)	(10.3)
Total turn time (minutes)	35.5	2.0	12.96
Number of logs	16.0	1.0	5.56
Volume per turn (board feet)	3,610	15	486
(m^3)	(16.3)	(0.07)	(2.2)
Weight (pounds)	25,326	220	3,691
(kg)	(11,498)	(100)	(1,676)
Total distance (feet)	4,100	100	1,029
(m)	(1,250)	(30.5)	(314)
Slope percent	15	-50	11

Equations (1) and (2) should be used if the skidder falls into the large or small skidder weight and horsepower classification. If an estimate of average turn times for a group of tractors of different sizes is desired use equation (3).

To facilitate solving the above equations for turn times use the nomographs shown in figures 1, 2, and 3. Each nomograph contains an example problem. The dotted lines in the figures illustrate how to use the graphs. To solve for other combinations of variables use any two straight-edged materials, preferably clear plastic, to locate

the index point on the nondimensioned scale. Connect the index point with the appropriate point on the total distance scale. The intersection of this line with the TT scale gives the turn time in minutes for the selected variables.

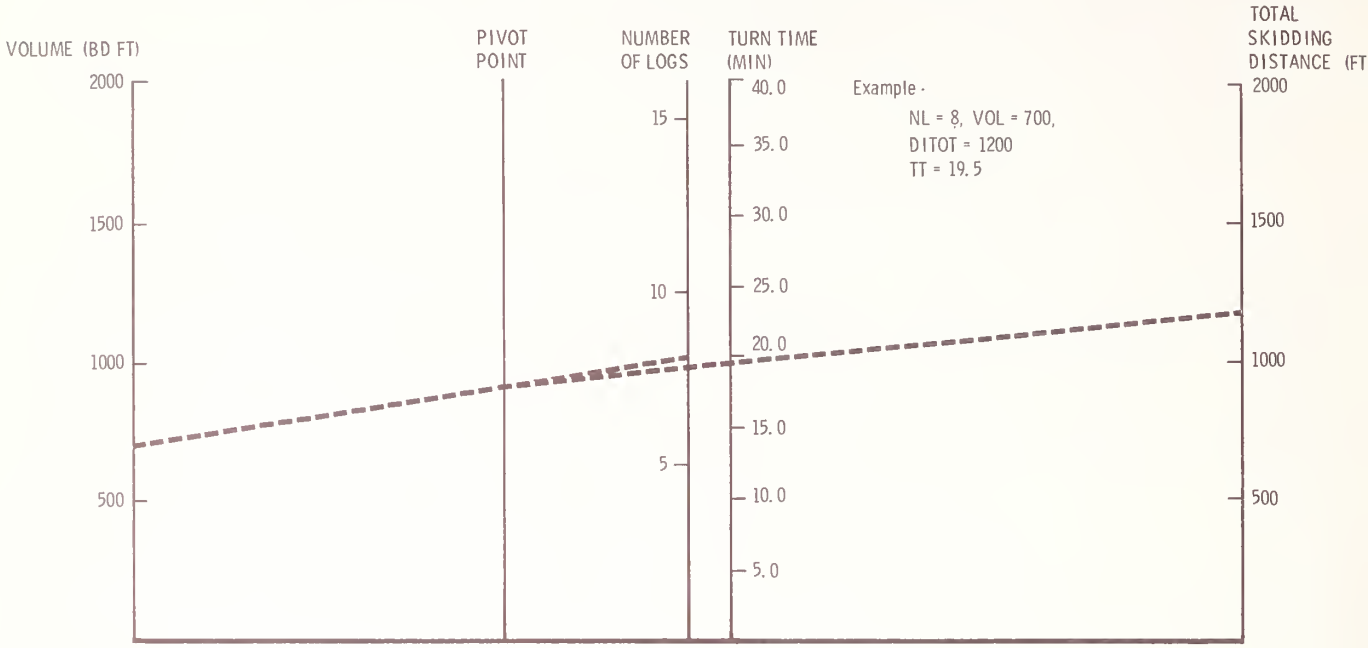

Figure 1.--*Large skidders*

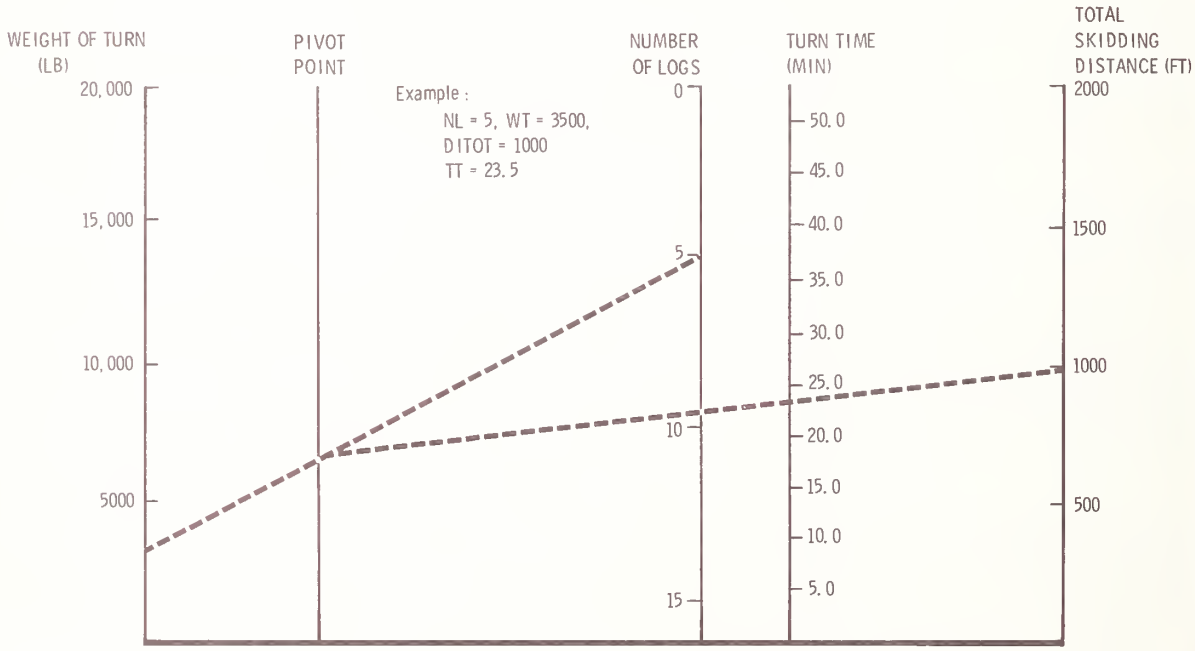

Figure 2.--*Small skidders*

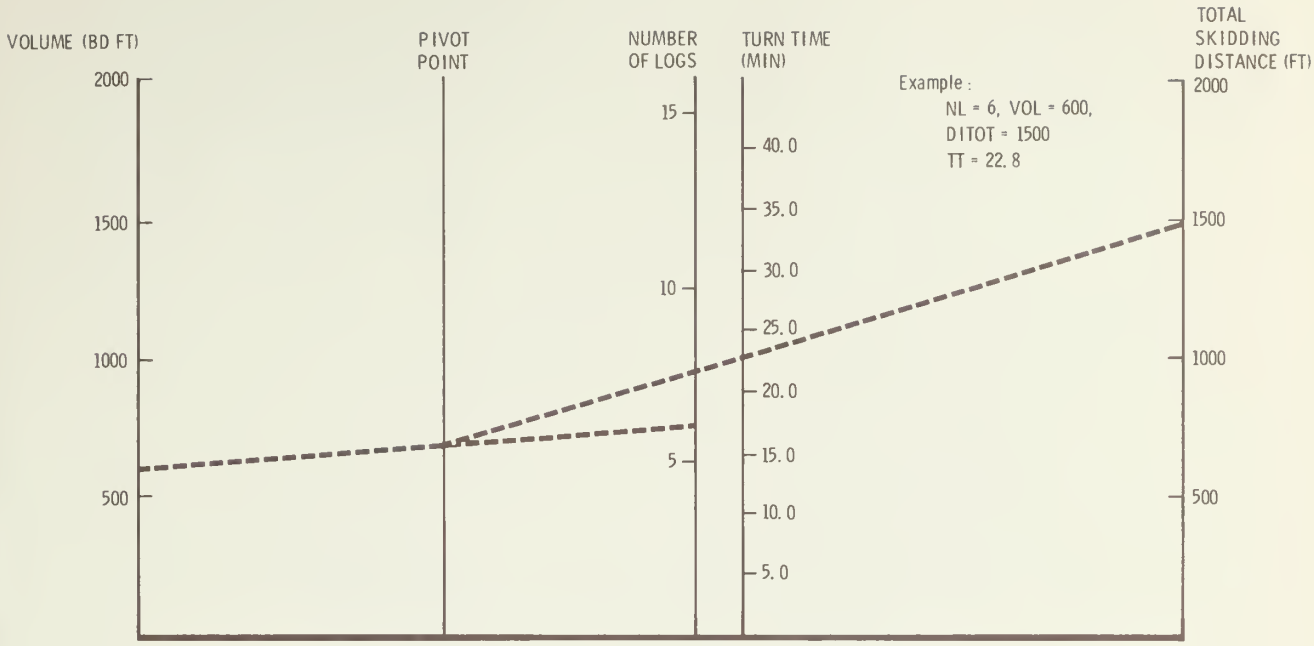

Figure 3.--*All skidders*

CONCLUSIONS

Turn cycle times for rubber tired skidders can be computed by using equations containing the three principal variables. The skidders were divided into two size classes by weight and horsepower to obtain better estimating equations. Also, an equation for all tractors is included. In this study better results were obtained for the heavier skidders whose turn times proved to be less variable.

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